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Reply to office action mailed 09/23/2003

Listing of the Claims:

1 (previously presented). A semiconductor device tester comprising

electron beam irradiation means for irradiating a semiconductor device as a sample under test with an electron beam while scanning the semiconductor device;

a current measuring means for measuring current flowing through the semiconductor resulting from irradiation by the electron beam; and

data processing means for processing measured data from said current measuring means,

wherein said electron beam irradiation means includes collimator means for collimating the electron beam to a parallel beam and means for changing an acceleration voltage of the electron beam and wherein said data processing means includes means for obtaining an information related to a structure of the sample in a depth direction on the basis of changes of the measured current of said current measuring means caused by a penetration depth of the electron beam for the sample when the latter is scanned with different acceleration voltages.

2 (currently amended). A semiconductor device tester as claimed in claim 1, further comprising means for moving said sample with respect to electron beam, wherein said electron beam irradiating means includes an electron gun and said collimator means includes a condenser lens for collimating electron beam emitted from said electron gun to parallel beam and an aperture plate having an aperture inserted into between said condenser lens and said sample for limiting a spot size of electron beam impinging said sample such that electron beam impinges an opening portion. ~~The electron beam irradiation means preferably includes means for moving the sample under test with respect to electron beam in order to scan the sample with electron beam.~~

3 (currently amended). A semiconductor device tester as claimed in claim 1, further comprising means for moving said sample under test with respect to electron beam in

order to scan said sample with electron beam, wherein said electron beam irradiation means includes an electron gun and said collimator means includes a first condenser lens for collimating electron beam emitted from said electron gun to parallel beam, a second condenser lens arranged such that said condenser lens constitutes an afocal system, an objective lens and an aperture plate having an aperture and inserted into between said first condenser lens and said second condenser lens for limiting a spot size of electron beam.

4 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said electron beam irradiating means includes means for vertically irradiating said sample along a line segment passing through a center of a measuring region of said sample with electron beam having spot size smaller than an area of said measuring region, and wherein said data processing means ~~includes means for obtaining~~ determines a distance of a bottom of said measuring region from a space between a rising and falling edges of a current measured along said line segment.

5 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said data processing means determines an area of an unknown measuring region by dividing ~~includes area calculation means, which divides~~ a value of current produced in an said unknown measuring region by electron beam irradiation of said unknown region with electron ~~beam~~ beam under constant condition by a value of current produced in a known area of a measuring region of a standard sample by electron beam irradiation thereof with electron beam under the same constant condition, and ~~obtains~~ the area of said unknown measuring region being obtained from a resulting quotient.

6 (currently amended). A semiconductor device tester as claimed in claim 5, wherein said data processing means determines a distance measured from one edge to the other of said unknown measuring region by dividing ~~includes distance calculation means, which divides~~ the area ~~obtained by said area calculation means~~ by the ratio of

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the circumference of a circle to its diameter ~~and obtains~~ to obtain a root of the resultant quotient ~~as a distance measured from one edge to the other of said unknown measuring region.~~

7 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said electron beam irradiation means sets ~~includes means for, setting~~ the spot size of electron beam to a value large enough to cover a whole measuring region in the lump and wherein said data processing means calculates ~~includes means for calculating~~ a ratio of a value of current produced when a standard sample including a measuring region having a known area is irradiated with electron beam having the large spot size to a value of current produced when a measuring region of an unknown sample is irradiated with electron beam having the large spot size and calculates ~~means for calculating~~ an area of the measuring region of the unknown sample from the ratio.

8 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said data processing means determines ~~includes means for determining~~ the value of current produced when a standard sample is irradiated with an electron beam having a known spot size as an amount of current per unit area of said standard sample.

9 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said data processing means compares ~~includes means for comparing~~ a current value measured for specified ~~correspondingly to a positional coordinates~~ for when a wafer under test irradiated with an electron beam with a standard ~~current~~ value ~~to be~~ measured at the same positional coordinates ~~of the~~ for a wafer that is good, and sets a ~~setting the kind of~~ process to be performed next on the basis of the result of the comparison.

10 (currently amended). A semiconductor device tester as claimed in claim 1, further comprising a secondary electron detector for detecting secondary electron emitted from a surface of a sample under test, wherein ~~said data processing means includes~~

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~~correspondingly processing means for processing~~ an amount of secondary electron measured by said secondary electron detector is compared with ~~correspondingly to the~~ result of measurement of said current measuring means by said data processing means.

11 (currently amended). A semiconductor device tester as claimed in claim 10, wherein said electron beam irradiating means includes means for vertically irradiating said sample under test along a line segment passing through a center of a measuring region with an electron beam having a spot size smaller than an area of said measuring region and said ~~correspondingly~~ data processing means obtains ~~includes means for obtaining~~ a bottom distance of said measuring region from a distance between a rising and falling edges of current measured along said line segment by ~~means of~~ said current measuring means and obtains ~~means for obtaining~~ an upper distance of said measuring region from a distance between a rising and falling edges of the secondary electron detected by said secondary electron detector.

12 (currently amended). A semiconductor device tester as claimed in claim 11, wherein said ~~correspondingly~~ data processing means displays in three dimensions ~~includes means for three-dimensionally displaying~~ a circular pillar or a frustum of a cone having a bottom distance, an upper distance and a film thickness obtained from the information of the measured bottom distance, upper distance and film thickness of the measuring region as a bottom diameter, an upper diameter and a height.

13 (currently amended). A semiconductor device tester as claimed in claim 1, further comprising tilting means for tilting a sample stage on which a sample under test is mounted, ~~wherein said data processing means includes means for processing a tilting angle of the sample with respect to electron beam, which is realized by said tilting means.~~

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14 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said data processing means stores ~~includes recording means for storing~~ a current value corresponding to an electron beam irradiating portion obtained in a location of the sample under test having no dust, ~~means for comparing~~ compares the stored current value ~~stored in said recording means~~ with a current value corresponding to an electron beam irradiating position in a pattern portion of an unknown sample; which is the same as a pattern portion of the sample under test, and determines the ~~means for determining~~ existence and size of dust from a difference between a rising and falling positions of the current value obtained by the comparison.

15 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said electron beam irradiation means sets ~~includes means for setting~~ a cross sectional shape of the electron beam such that it covers the whole measuring region in the lump and at least one end of the cross sectional shape ~~of electron beam becomes~~ is linear, and said data processing means obtains ~~includes means for obtaining~~ the bottom distance of the measuring region from a distance between a rising value and a maximum value of current.

16 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said electron beam irradiation means ~~includes means for setting~~ sets a cross sectional shape of electron beam such that it covers a whole measuring region in the lump and at least one end of the cross sectional shape ~~of electron beam becomes~~ linear and said data processing means calculates ~~includes means for calculating~~ a differentiated curve of current value with respect to a distance and obtains ~~means for obtaining~~ a radius of a bottom portion of the measuring region from a distance between a rising position and an apex position of the differentiated curve.

17 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said data processing means directs the display of ~~includes means for displaying~~ measured current values on a map corresponding to the measured positions.

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18 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said data processing means compares ~~includes comparison means for comparing~~ a measured value obtained in one of two regions on a wafer as samples under test with a measured value obtained in the other region as a reference value and extracts ~~means for extracting~~ a positional coordinates when there is a difference equal to or larger than a predetermined constant value.

19 (currently amended). A semiconductor device tester as claimed in claim 18, wherein said electron beam irradiation means scans ~~includes means for scanning~~ a sample under test with a linear electron beam having length substantially equal to a width of a wiring in a direction perpendicular to a lengthwise direction of the linear line and ~~moving~~ moves a scan position by a distance equal to the width of the wiring vertically to scanning direction after one line scan is completed, and said data processing means compares ~~comparison means includes means for comparing~~ current waveforms measured as variations of current values with respect to electron beam irradiating positions in the two regions.

20 (currently amended). A semiconductor device tester as claimed in claim 18, wherein said electron beam irradiation means scans ~~includes means for scanning~~ a sample under test with an electron beam having size smaller than a minimum width of a wiring of the sample in a first direction and moving the scan position in a direction perpendicular to the scanning direction by a distance corresponding to the ~~with~~ width of the wiring every time one line scan is completed, and said data processing means extracts ~~comparison means includes means for extracting~~, from current waveforms measured as variations of current values corresponding to electron beam irradiating positions in the two regions, instantaneous current values at centers of a rising and falling which correspond ~~corresponding~~ to the same pattern positions and compares ~~comparing~~ the instantaneous current values with each other.

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21 (currently amended). A semiconductor device tester as claimed in claim 18, wherein said electron beam irradiation means scans ~~includes means for scanning~~ a sample under test with linear electron beam having a length capable of irradiating a plurality of wiring lines of the sample in the lump in a direction perpendicular to a lengthwise direction of the linear electron beam and moves ~~moving~~ the sample in a direction perpendicular to the scanning direction by a width of electron beam irradiating a scan position every time when one line scan is completed, and said data processing ~~comparison~~ means compares ~~includes means for comparing~~ current waveforms measured as variations of current values for electron beam irradiating positions in the two regions.

22 (currently amended). A semiconductor device tester as claimed in claim 21, wherein said data processing ~~means integrates~~ ~~means for comparing waveforms~~ ~~includes means for integrating~~ the waveforms and compares ~~comparing~~ the integrated values.

23 (currently amended). A semiconductor device tester as claimed in claim 18, wherein said data processing ~~means integrates~~ ~~comparison means includes means for~~ ~~integrating~~ current from a rising edge to a falling edge of one pulse of a current waveform measured as a variation of a value of current from an electron beam irradiating position, and divides ~~divider means for dividing~~ the integrated value by a distance between the rising edge and the falling edge of the pulse and compares ~~means for comparing~~ current values per unit area of the two regions obtained by ~~said divider means~~ the division.

24 (currently amended). A semiconductor device tester as claimed in claim 18, wherein said data processing ~~means compares~~ ~~comparison means includes means for~~ ~~comparing~~ positions of a rising edge and a falling edge of the pulse of the current waveform measured as a variation of current value for an electron beam irradiating position.

25 (currently amended). A semiconductor device tester as claimed in claim 18, wherein said data processing means compares ~~comparison means includes means for comparing~~ center positions of a rising edge position and a falling edge position of the pulse of the current waveform measured as a variation of current value for an electron beam irradiating position.

26 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said electron beam irradiation means scans so as to move ~~includes main scan means for moving~~ a sample under test with respect to electron beam and sub scans by scan ~~means for repeatedly deflecting an~~ electron ~~beam~~ beam in a direction different from a main scan direction in combination on the main scan.

27 (original). A semiconductor device tester as claimed in claim 1, wherein said electron beam irradiation means is capable of switching an operation mode between a first mode in which individual wiring lines of a sample under test are irradiated with electron beam and a second mode in which all of the wiring lines of the sample are irradiated with electron beam in the lump and said data processing means includes means for analyzing, every constant positional section, spacial frequency of current waveform measured as a variation of current value for electron beam irradiating position in the first mode and detecting a portion in which positional sections having the same spacial frequency continue for a constant time period and means for, under an assumption that a plurality of wiring lines are arranged in an array in the detected position, setting the electron beam irradiation means to the second mode and obtaining defect ratio in the lump.

28 (currently amended). A semiconductor device tester as claimed in claim 1, said means for obtaining information related to the structure in the depth direction obtains ~~includes means for obtaining~~ a three-dimensional configuration of a through-hole provided in an insulating film by measuring values of current produced by irradiation

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of an electron beam passing through the insulating film surrounding the through-hole with increased acceleration voltage.

29 (currently amended). A semiconductor device tester as claimed in claim 28, further comprising means for tilting a sample stage having a sample under test mounted ~~thereon thereof~~, wherein said data processing means determines ~~means for obtaining the three-dimensional configuration includes means for detecting~~ whether a diameter of a throughhole is increased or decreased with depth ~~from~~ measured values obtained when an electron beam and an incident angle of the electron beam relative to the sample are changed.

30 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said means for obtaining information related to a structure in a depth direction detects ~~a includes means for detecting~~ deviation of a circuit pattern in an insulating film from a measured value of current produced by an electron beam passing through the insulating film.

31 (currently amended). A semiconductor device tester as claimed in claim 30, wherein said data processing means evaluates ~~wherein said means for detecting deviation of circuit pattern includes means for evaluating~~ a deviation of circuit patterns in respective layers from measured values when a penetrating depth of electron beam is changed by changing acceleration voltage.

32 (currently amended). A semiconductor device tester as claimed in claim 30, wherein said data processing means takes in ~~further comprising means for taking in~~ ~~an~~ information related to the circuit patterns from CAD data to obtain a position in which the circuit patterns overlap in the insulating layer.

33 (currently amended). A semiconductor device tester as claimed in claim 1, wherein said data processing means corrects for a ~~includes means for correcting~~

current component flowing through a capacitance of a sample under test; which is caused by irradiation frequency of electron beam or scanning frequency.

34 (currently amended). A semiconductor device tester as claimed in claim 33, ~~further comprising means for changing a repetition period of electron beam,~~ wherein said electron beam irradiation means has a changeable repetition period for the electron beam and has a construction in which a pulsed electron beam is generated repeatedly, ~~and said data processing means obtains and said correcting means includes means for obtaining~~ the D.C. component by extrapolation of current value when the sample is continuously irradiated with an electron beam from current values measured by the current measuring means when the sample is irradiated with an electron beam with different repetition period.

35 (currently amended). A semiconductor device tester as claimed in claim 33, ~~further comprising means for switching scan speed of electron beam from~~ wherein said electron beam irradiation means is capable of switching a scan speed of the electron beam, ~~and~~ wherein said data processing means obtains ~~correcting means includes means for obtaining~~ a current value when the scanning speed, ~~which is zero,~~ is extrapolated from the current values measured by said current measuring means when the sample is scanned by an electron beam at different scan speeds.